

Habitat Modeling using Airborne LIDAR

Analysis of the Black-capped Vireo Habitat at Fort Hood, Texas

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Our problem:

The description of the vertical distribution of resources, such as vegetation cover, by traditional remote sensing methods is limited. Black-capped vireo habitat possesses a vertical component that cannot be identified using traditional remote sensed data

Our hypothesis:

LIDAR data can be used as an alternative to delineate black-capped vireo habitat at Fort Hood, Texas

Our goal:

To delineate black-capped vireo habitat at Fort Hood using LIDAR.

Habitat Types

Donut –

- Circular in shape
- Produced by military training



Classical –

- Irregular in shape
- Shrubland



Linear –

- Irregular in shape
- Roads



Examples of remotely-sensed data used for habitat delineation:

Examples:

LANDSAT Thematic Mapper (TM) 30 m

Digital Ortho Quarter Quads (DOQQs) 1 m

Uses:

Classification and compositional mapping

Limitations:

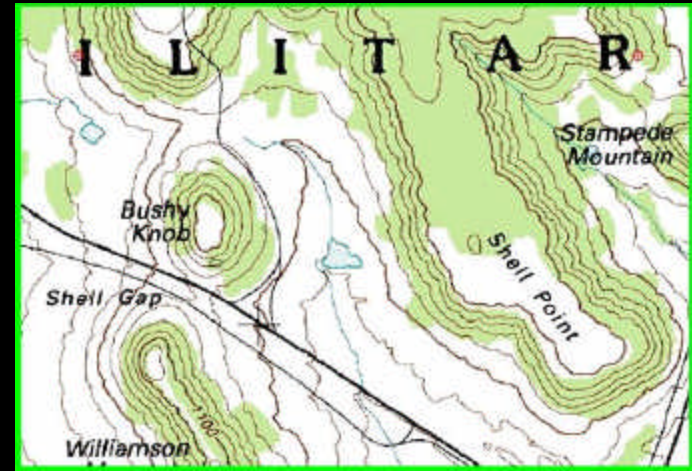
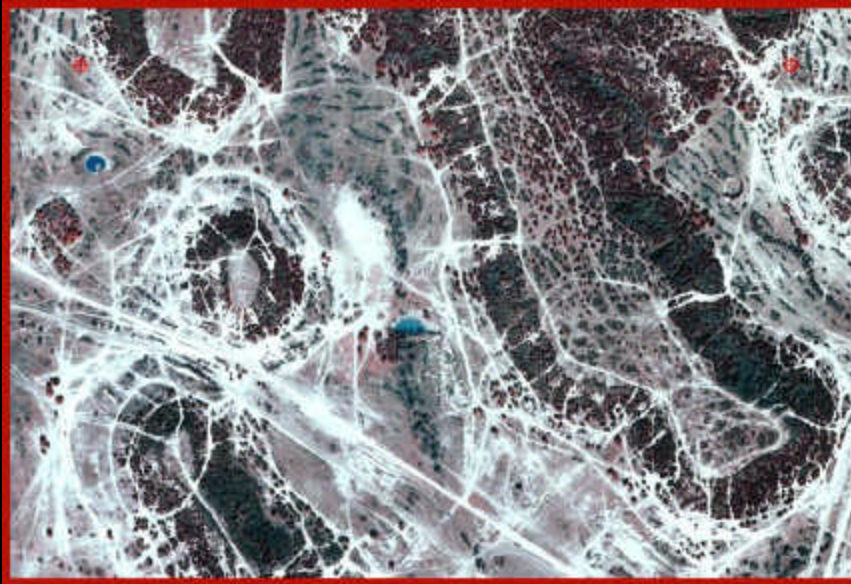
Vertical structure* is not discernible



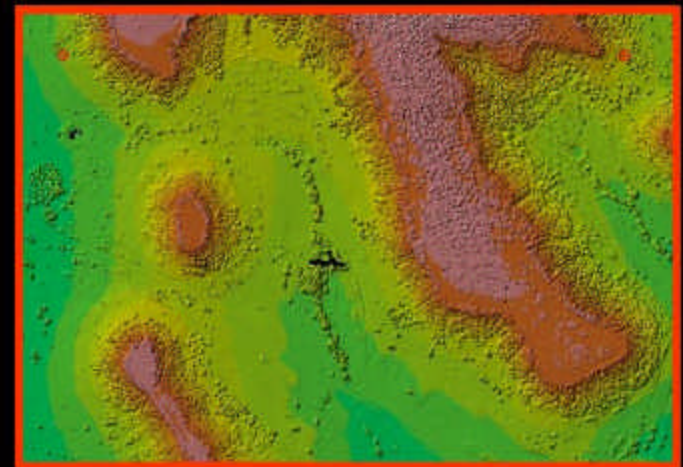
* Measurement of different vertical layers


Traditional remotely-sensed data products:

Surface contours
without vegetation →



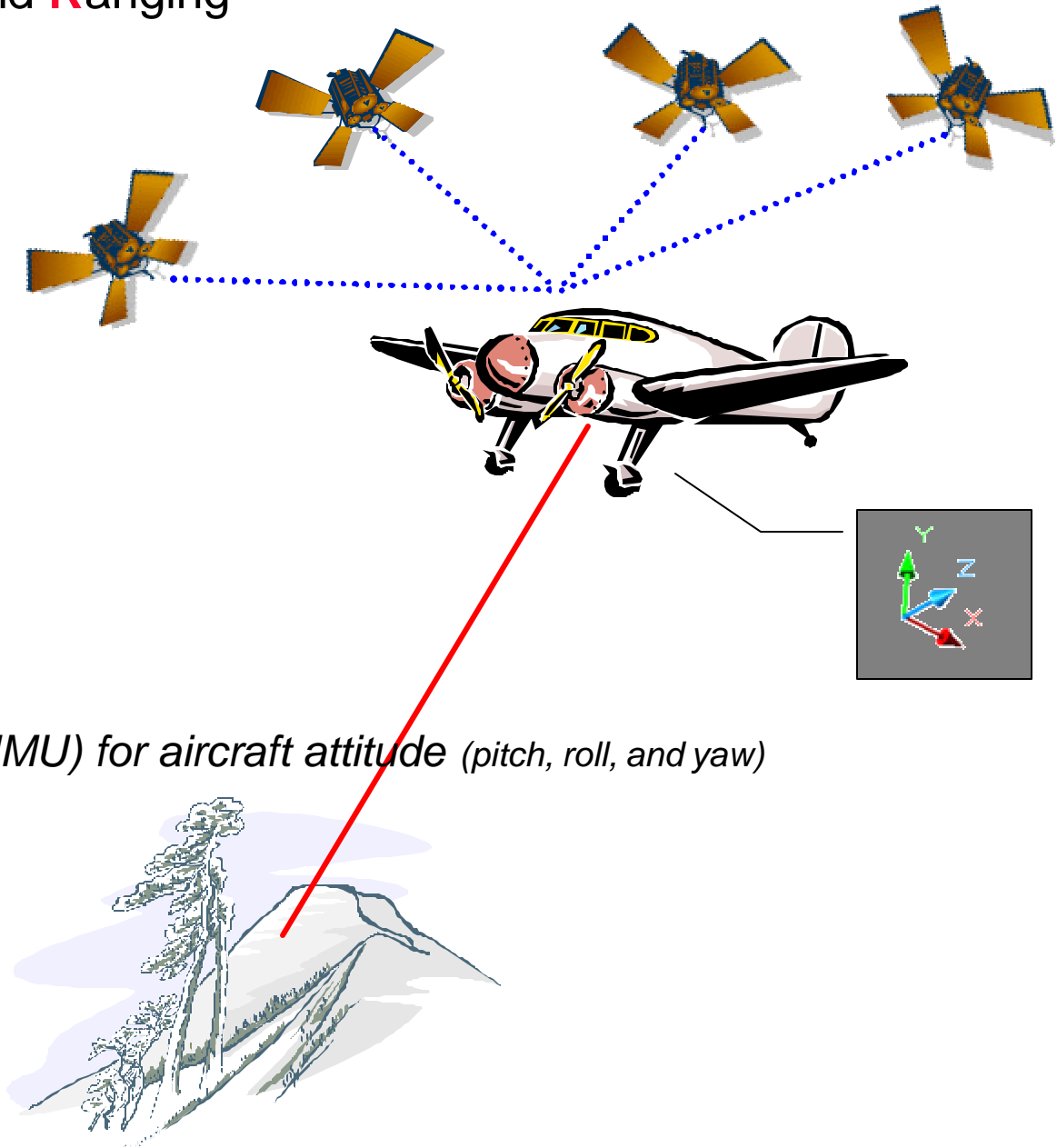
Canopy heights
for top layer only →



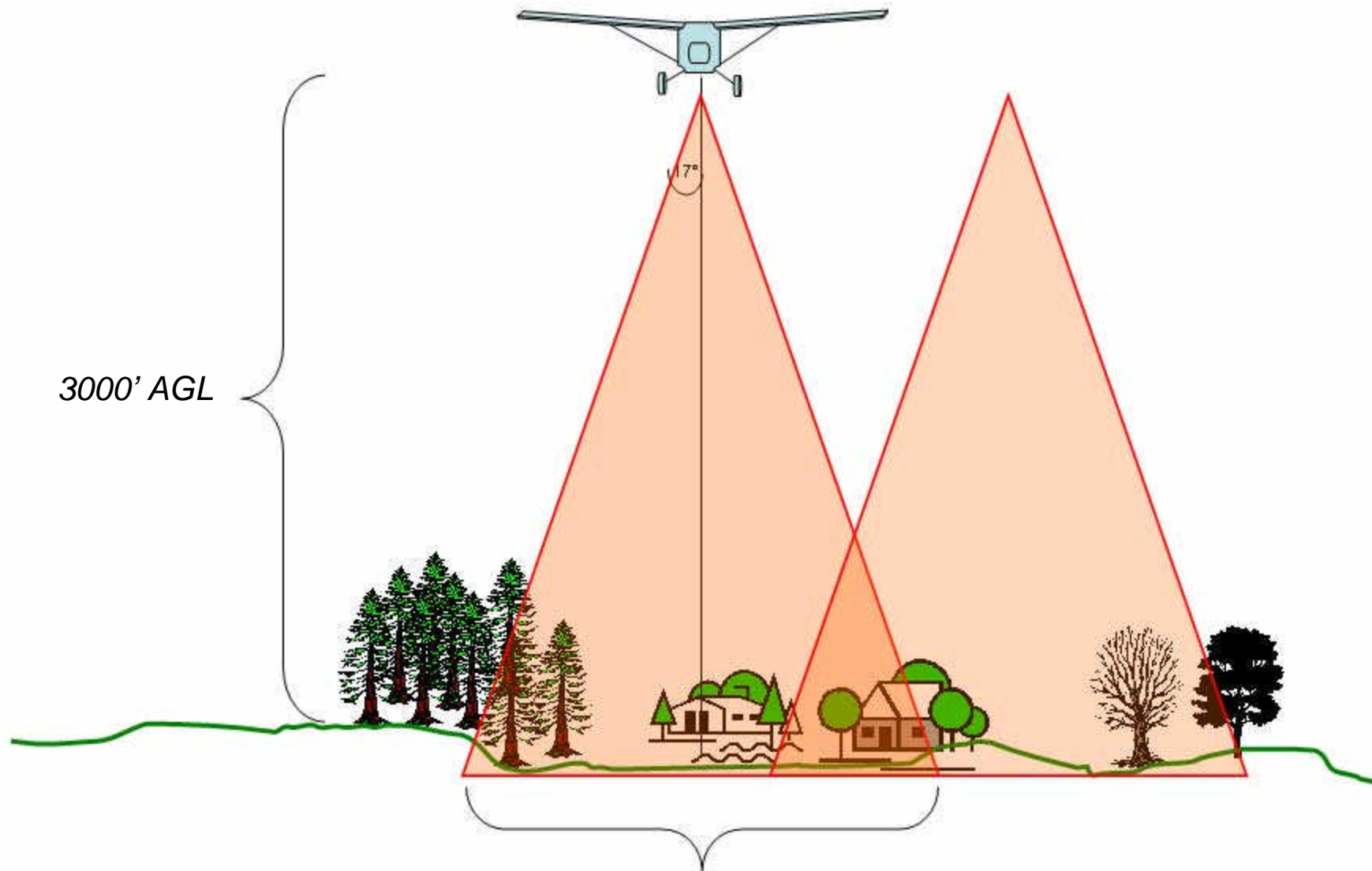
A photograph of a dirt path leading through a dense forest of green trees and bushes. The path is light brown and winds from the foreground into the distance. The vegetation is lush and green, with some trees showing bare branches. The sky is blue with some light clouds.

Standard remote sensing methods are inadequate for determining black-capped vireo habitat because vertical structure is important for the species

Airborne **L**ight **D**etection **A**nd **R**anging (**LIDAR**) Systems

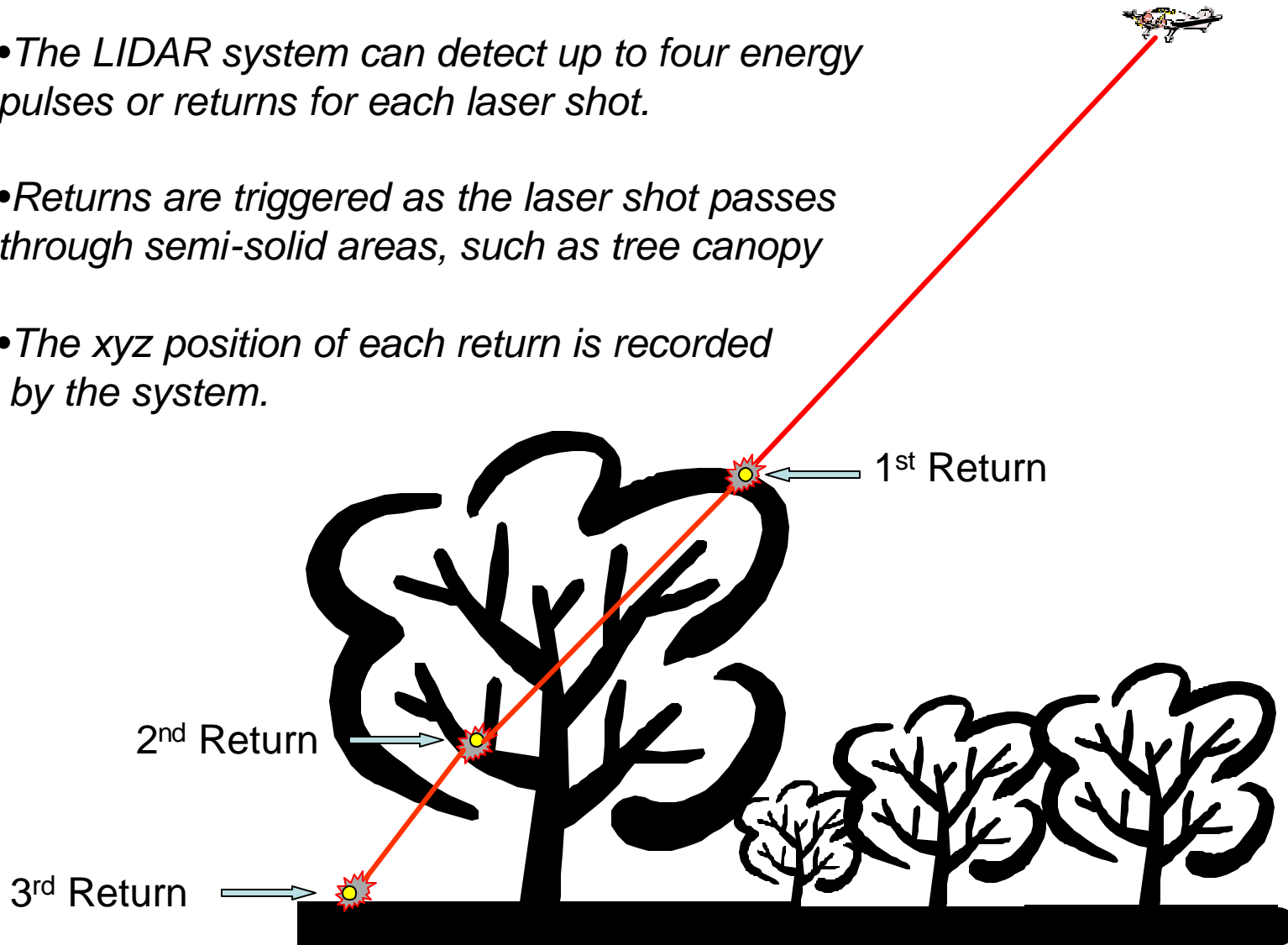


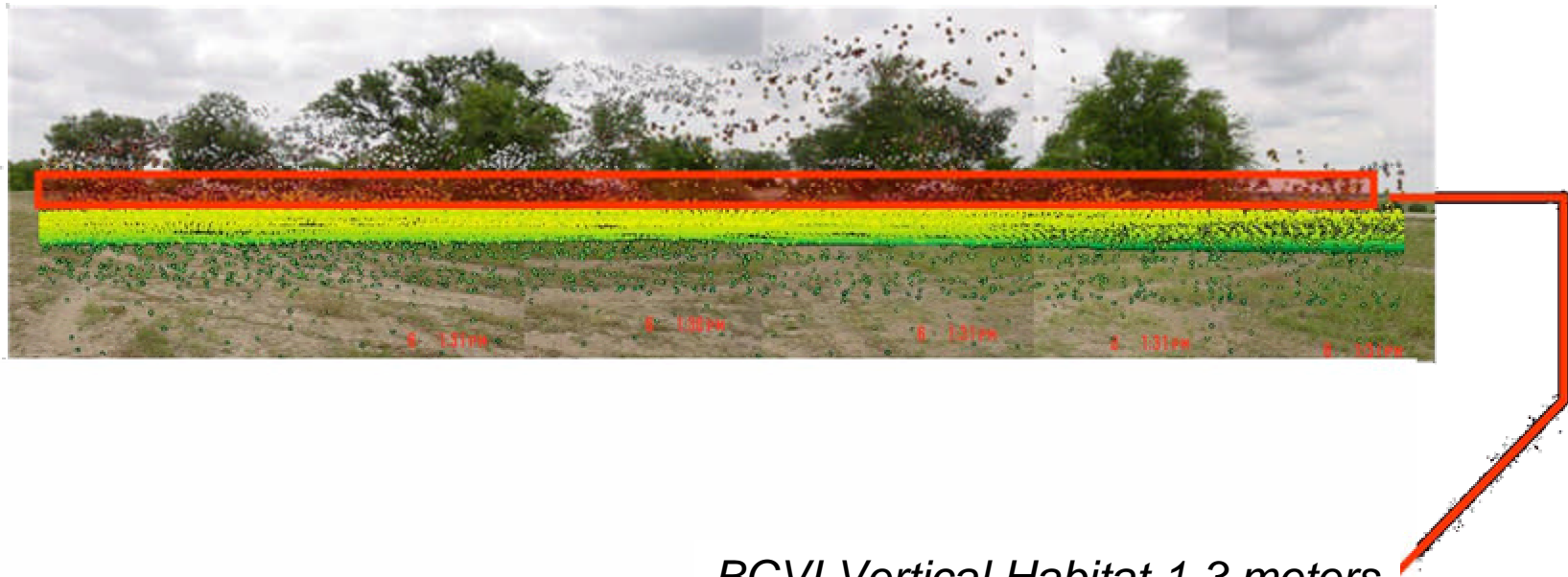
- **Laser** ranging from aircraft
- Measure distance to earth
- GPS for aircraft position
- Internal Measurement Unit (IMU) for aircraft attitude (pitch, roll, and yaw)



- 20,000 pulses per second
- 450,000 data points per square km.
- Rotating mirror, regularly spaced scan pattern

- The LIDAR system can detect up to four energy pulses or returns for each laser shot.
- Returns are triggered as the laser shot passes through semi-solid areas, such as tree canopy
- The xyz position of each return is recorded by the system.





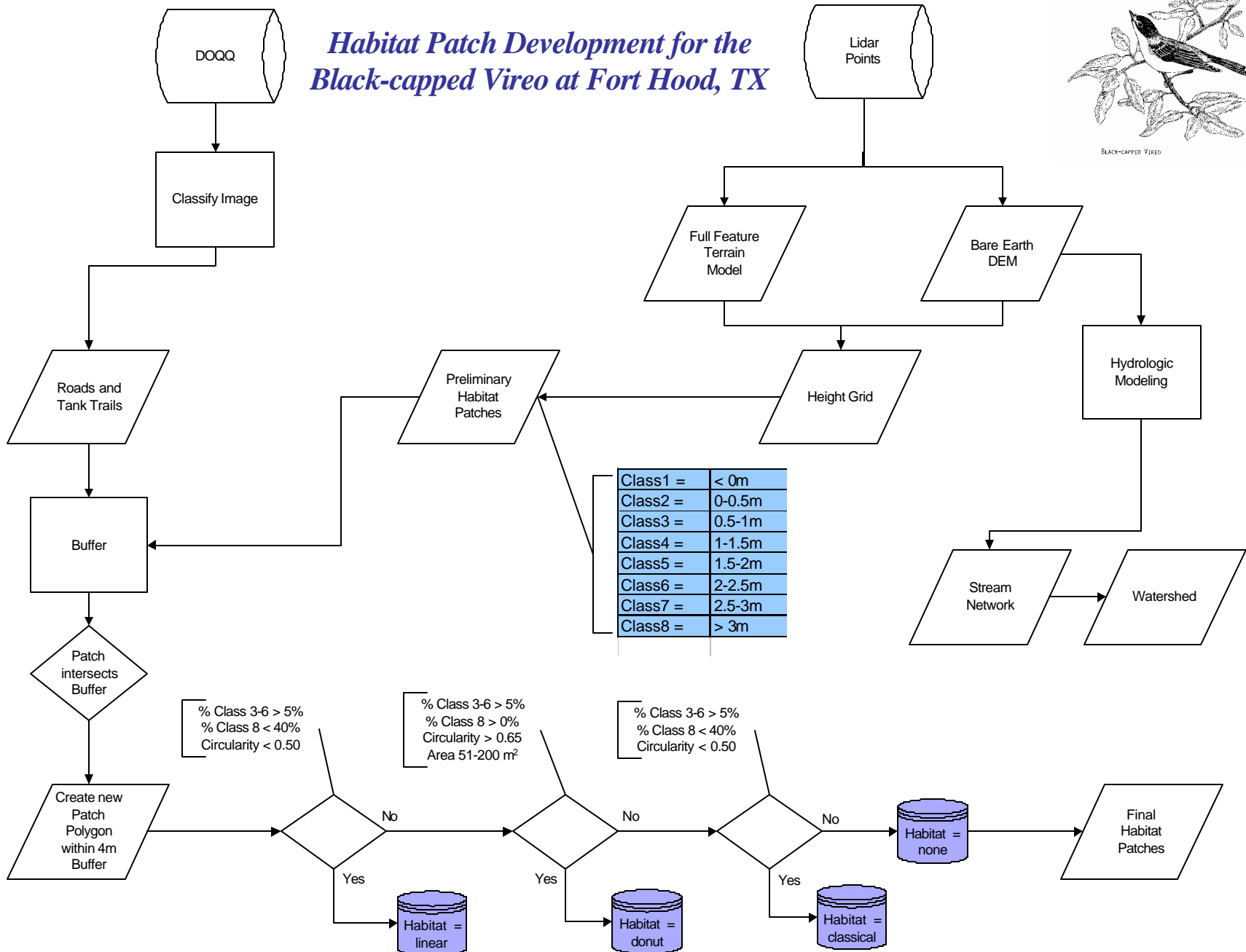
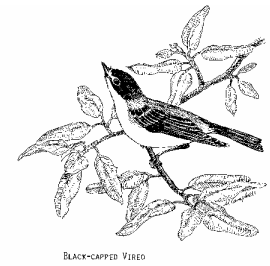
BCVI Vertical Habitat 1-3 meters

LIDAR provides the unique ability to map height within the canopy.




Methods

Habitat Patch Development for the Black-capped Vireo at Fort Hood, TX



Vegetation classes :

A large, dense green tree with a full canopy stands in a field. The ground is covered with dry, light-colored vegetation and some green grass. The sky is a clear, bright blue.

Class 1	< 0 m
Class 2	0.0 - 0.5 m
Class 3	0.5 - 1.0 m
Class 4	1.0 - 1.5 m
Class 5	1.5 - 2.0 m
Class 6	2.0 - 2.5 m
Class 7	2.5 - 3.0 m
Class 8	> 3 m

Habitat Types

Donut –

- Circular in shape
- Area approx. 50-200 square meters
- Contains some class 8 vegetation
- At least 5% class 3-6 vegetation
- Created from tank movement



Classical –

- Irregular in shape
- Contains < 40% class 8 vegetation
- At least 5% class 3-6 vegetation



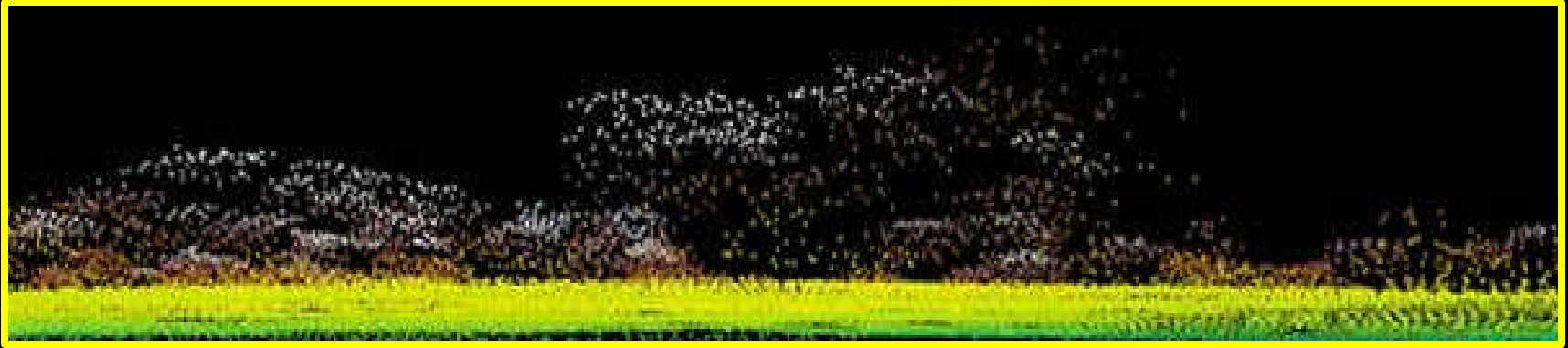
Linear –

- Irregular in shape
- Within 4 meters of tank trail or road
- Contains < 40% class 8 vegetation
- At least 5% class 3-6 vegetation



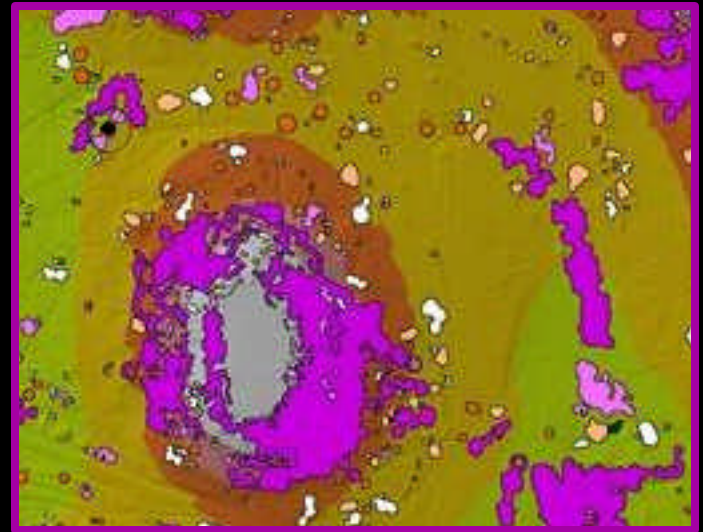
Habitat Patches:

LIDAR points were processed into potential habitat patches



Class heights were assigned to each habitat patch

Patches were classified into: classical, donut, or linear habitat using shape, texture, and proximity to linear features



Field Data Collection

A custom ArcPad 6.0 application was developed for field data collection

We used the ArcPad application to visit 150 randomly selected patches (50 per habitat type)



Preliminary Results*

Three habitat types were expected to be identified, however an additional habitat type (mixed) was observed in the field.

Vertical structure of vegetation was clearly identified by LIDAR.

* Results to be reported in *Endangered species monitoring and management at Fort Hood, Texas: 2002 annual report*.

Preliminary Results*

Classification accuracy varied among habitat types.

		Misclassified		
Habitat Type	Correctly classified	Habitat type	Vegetation ¹	Total
Donut	44	24	32	100
Classical	57	8	35	100
Linear	8	48	44	100

¹ The lack of concurrent high-resolution multispectral imagery for use in excluding Ashe juniper habitat from our analyses resulted in misclassification errors.

* Results to be reported in *Endangered species monitoring and management at Fort Hood, Texas: 2002 annual report*.

Preliminary Results*

Error sources:

- Only 3 habitat types were defined
- Vegetation classification was needed to remove areas covered with juniper
- Habitat delineation may need to be divided into three steps:
 - Donut habitat identification
 - Classical and mixed habitats classification
 - Linear habitat classification

* Results to be reported in *Endangered species monitoring and management at Fort Hood, Texas: 2002 annual report*.

Discussion:

Vertical vegetation structure was successfully identified using LIDAR.

- Vegetation height estimates were possible using LIDAR.
- Use of multispectral imagery combined with LIDAR is expected to increase accuracy levels.
- LIDAR data can provide not only habitat information at Fort Hood, but other valuable products such as DEMs, slope/aspect, hydrologic networks/watersheds, building footprints, etc.

Conclusions

- LIDAR data offer a promising tool for modeling the vertical structure of vegetation
- The use of LIDAR data in combination with remotely-sensed data may improve endangered species habitat delineation
- LIDAR sub-products include the generation of DEMs, stream networks, watershed boundaries, among others
- LIDAR can be used to generate/support other research projects

Future directions:

Addition of mixed habitat into classification

3-D vegetation modeling to identify classical and mixed habitat

Use of multispectral imagery to remove areas occupied by juniper

Production of a habitat model

